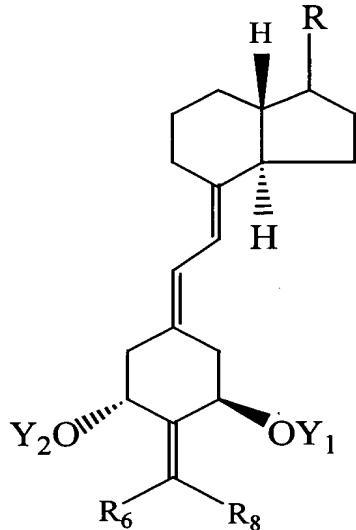


CLAIMS

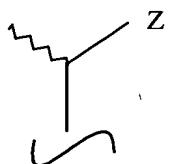
We claim:

1. A compound having the formula:

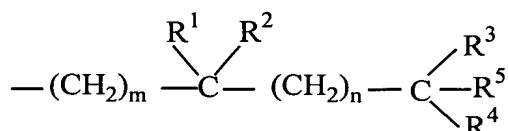


where Y_1 and Y_2 , which may be the same or different, are each selected from the group consisting of hydrogen and a hydroxy-protecting group, R_6 and R_8 , which may be the same or different, are each selected from the group consisting of

- 5 hydrogen, alkyl, hydroxyalkyl and fluoroalkyl, or, when taken together represent the group $-(CH_2)_x-$ where x is an integer from 2 to 5, and where the group R is represented by the structure:

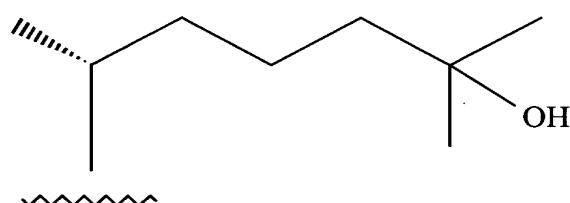


where the stereochemical center at carbon 20 may have the R or S configuration, and where Z is selected from Y, -OY, -CH₂OY, -C≡CY and -CH=CHY, where the double bond may have the cis or trans geometry, and where Y is selected from hydrogen, methyl, -COR⁵ and a radical of the structure:

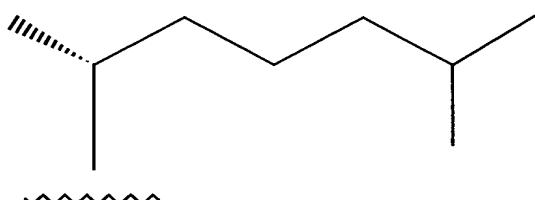


where m and n, independently, represent the integers from 0 to 5, where R¹ is
15 selected from hydrogen, deuterium, hydroxy, protected hydroxy, fluoro,
trifluoromethyl, and C₁₋₅-alkyl, which may be straight chain or branched and,
optionally, bear a hydroxy or protected-hydroxy substituent, and where each of R²,
R³, and R⁴, independently, is selected from deuterium, deuteroalkyl, hydrogen,
fluoro, trifluoromethyl and C₁₋₅ alkyl, which may be straight-chain or branched,
20 and optionally, bear a hydroxy or protected-hydroxy substituent, and where R¹ and
R², taken together, represent an oxo group, or an alkylidene group, =CR²R³, or the
group -(CH₂)_p-, where p is an integer from 2 to 5, and where R³ and R⁴, taken
together, represent an oxo group, or the group -(CH₂)_q-, where q is an integer from
2 to 5, and where R⁵ represents hydrogen, hydroxy, protected hydroxy, or C₁₋₅
25 alkyl and wherein any of the CH-groups at positions 20, 22, or 23 in the side chain
may be replaced by a nitrogen atom, or where any of the groups -CH(CH₃)-,
-(CH₂)_m-, -(CH₂)_n-, or -(CR₁R₂)- at positions 20, 22, and 23, respectively, may be
replaced by an oxygen or sulfur atom.

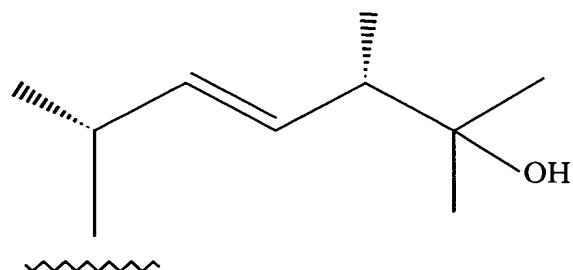
2. The compound of claim 1 where R is a side chain of the formula



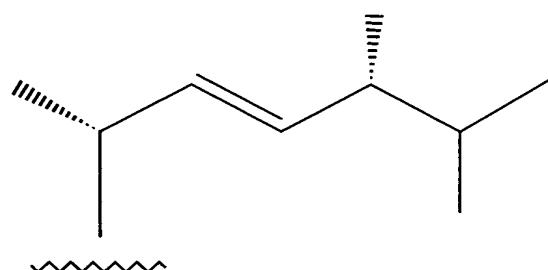
3. The compound of claim 1 where R is a side chain of the formula



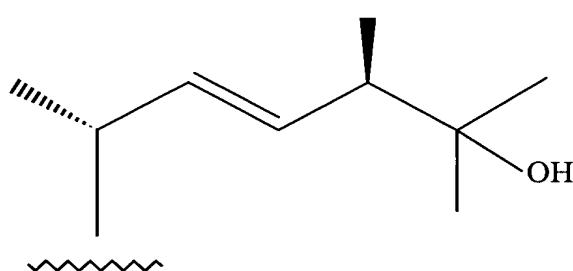
4. The compound of claim 1 where R is a side chain of the formula



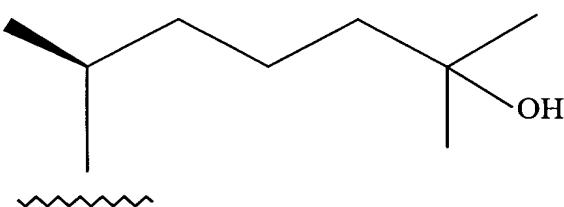
5. The compound of claim 1 where R is a side chain of the formula



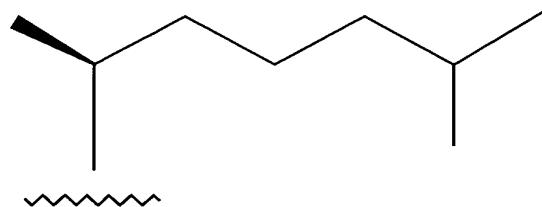
6. The compound of claim 1 where R is a side chain of the formula



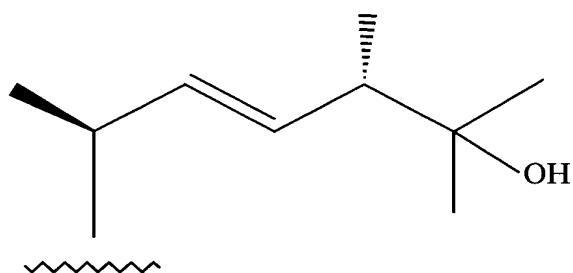
7. The compound of claim 1 where R is a side chain of the formula



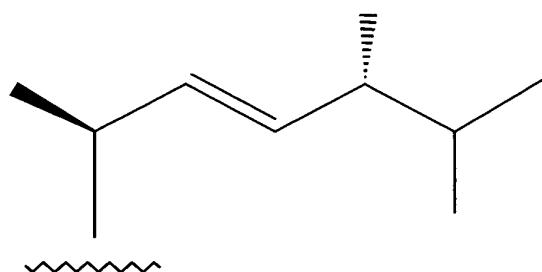
8. The compound of claim 1 where R is a side chain of the formula



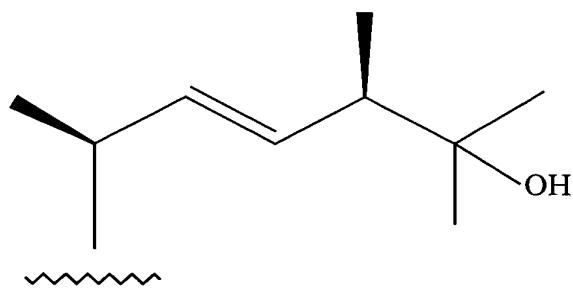
9. The compound of claim 1 where R is a side chain of the formula



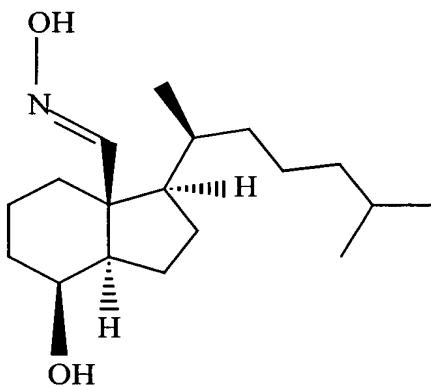
10. The compound of claim 1 where R is a side chain of the formula



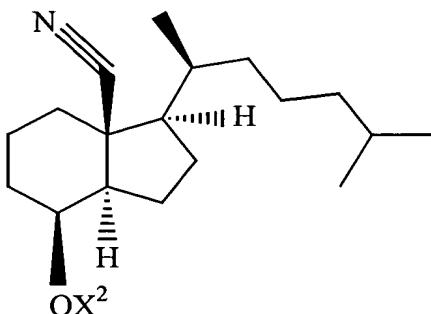
11. The compound of claim 1 where R is a side chain of the formula



12. (20S)-2-methylene-18,19-dinor-1 α ,25-dihydroxyvitamin D₃.
13. A pharmaceutical composition containing an effective amount of at least one compound as claimed in claim 1 together with a pharmaceutically acceptable excipient.
14. The pharmaceutical composition of claim 13 wherein said effective amount comprises from about 0.01 μ g to about 100 μ g per gram of composition.
15. The pharmaceutical composition of claim 13 wherein said effective amount comprises from about 0.1 μ g to about 50 μ g per gram of composition.
16. The pharmaceutical composition of claim 13 containing (20S)-2-methylene-18,19-dinor-1 α ,25-dihydroxyvitamin D₃ in an amount from about 0.01 μ g to about 100 μ g.
17. The pharmaceutical composition of claim 13 containing (20S)-2-methylene-18,19-dinor-1 α ,25-dihydroxyvitamin D₃ in an amount from about 0.1 μ g to about 50 μ g.
18. A compound having the formula:

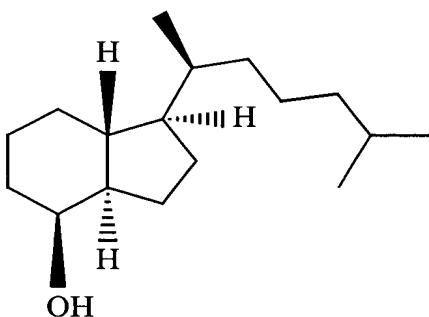


19. A compound having the formula:

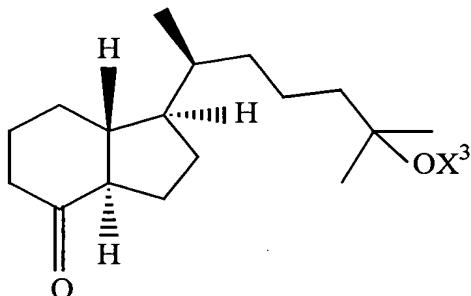


where X^2 is $-H$ or a hydroxy protecting group.

20. A compound having the formula:



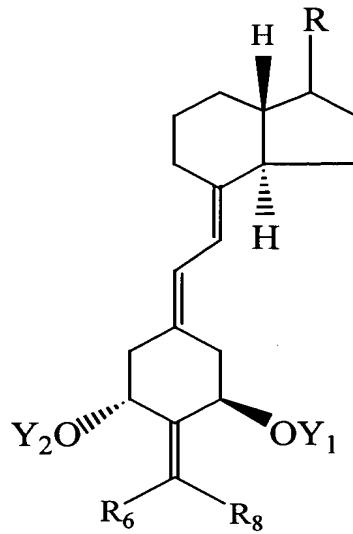
21. A compound having the formula:



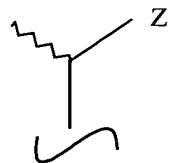
where X^3 is $-H$ or a hydroxy protecting group.

22. A method of treating metabolic bone disease where it is desired to maintain or increase bone mass comprising administering to a patient with said disease an effective amount of a compound having the formula:

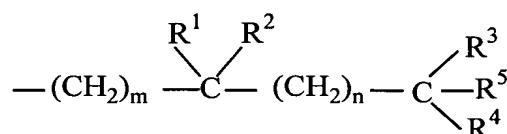
5



where Y_1 and Y_2 , which may be the same or different, are each selected from the group consisting of hydrogen and a hydroxy-protecting group, R_6 and R_8 , which may be the same or different, are each selected from the group consisting of hydrogen, alkyl, hydroxyalkyl and fluoroalkyl, or, when taken together represent the group $-(CH_2)_x-$ where x is an integer from 2 to 5, and where the group R is represented by the structure:



where the stereochemical center at carbon 20 may have the R or S configuration, and where Z is selected from Y , $-OY$, $-CH_2OY$, $-C\equiv CY$ and $-CH=CHY$, where the double bond may have the cis or trans geometry, and where Y is selected from hydrogen, methyl, $-COR^5$ and a radical of the structure:



where m and n , independently, represent the integers from 0 to 5, where R^1 is selected from hydrogen, deuterium, hydroxy, protected hydroxy, fluoro,

trifluoromethyl, and C₁₋₅-alkyl, which may be straight chain or branched and, optionally, bear a hydroxy or protected-hydroxy substituent, and where each of R², R³, and R⁴, independently, is selected from deuterium, deuteroalkyl, hydrogen, fluoro, trifluoromethyl and C₁₋₅ alkyl, which may be straight-chain or branched, and optionally, bear a hydroxy or protected-hydroxy substituent, and where R¹ and R², taken together, represent an oxo group, or an alkylidene group, =CR²R³, or the group -(CH₂)_p-, where p is an integer from 2 to 5, and where R³ and R⁴, taken together, represent an oxo group, or the group -(CH₂)_q-, where q is an integer from 2 to 5, and where R⁵ represents hydrogen, hydroxy, protected hydroxy, or C₁₋₅ alkyl and wherein any of the CH-groups at positions 20, 22, or 23 in the side chain may be replaced by a nitrogen atom, or where any of the groups -CH(CH₃)-, -(CH₂)_m-, -(CH₂)_n- or -(CR₁R₂)- at positions 20, 22, and 23, respectively, may be replaced by an oxygen or sulfur atom.

23. The method of claim 22 where the disease is senile osteoporosis.

24. The method of claim 22 where the disease is postmenopausal osteoporosis.

25. The method of claim 22 where the disease is steroid-induced osteoporosis.

26. The method of claim 22 where the disease is low bone turnover osteoporosis.

27. The method of claim 22 where the disease is osteomalacia.

28. The method of claim 22 where the disease is renal osteodystrophy.

29. The method of claim 22 wherein the compound is administered orally.

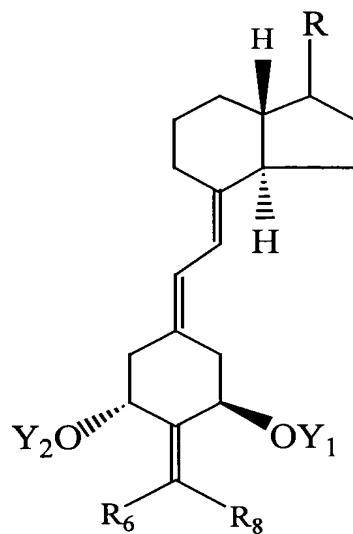
30. The method of claim 22 wherein the compound is administered parenterally.

31. The method of claim 22 wherein the compound is administered transdermally.

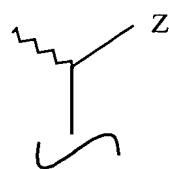
32. The method of claim 22 wherein the compound is administered in a dosage of from 0.01 μ g to 100 μ g per day.

33. The method of claim 22 wherein the compound is (20S)-2-methylene-18,19-dinor-1 α ,25-dihydroxyvitamin D₃.

34. A method of treating psoriasis comprising administering to a patient with psoriasis an effective amount of a compound having the formula:

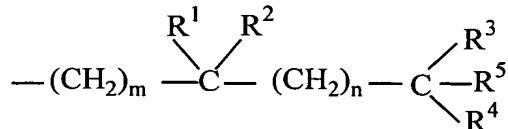


5 where Y₁ and Y₂, which may be the same or different, are each selected from the group consisting of hydrogen and a hydroxy-protecting group, R₆ and R₈, which may be the same or different, are each selected from the group consisting of hydrogen, alkyl, hydroxyalkyl and fluoroalkyl, or, when taken together represent the group $-(CH_2)_x-$ where x is an integer from 2 to 5, and where the group R is
10 represented by the structure:



where the stereochemical center at carbon 20 may have the R or S configuration, and where Z is selected from Y, -OY, -CH₂OY, -C≡CY and -CH=CHY, where the double bond may have the cis or trans geometry, and where Y is selected from

15 hydrogen, methyl, -COR⁵ and a radical of the structure:



where m and n, independently, represent the integers from 0 to 5, where R¹ is selected from hydrogen, deuterium, hydroxy, protected hydroxy, fluoro, trifluoromethyl, and C₁₋₅-alkyl, which may be straight chain or branched and,

20 optionally, bear a hydroxy or protected-hydroxy substituent, and where each of R²,
 R³, and R⁴, independently, is selected from deuterium, deuteroalkyl, hydrogen,
 fluoro, trifluoromethyl and C₁₋₅ alkyl, which may be straight-chain or branched,
 and optionally, bear a hydroxy or protected-hydroxy substituent, and where R¹ and
 R², taken together, represent an oxo group, or an alkylidene group, =CR²R³, or the
 25 group -(CH₂)_p-, where p is an integer from 2 to 5, and where R³ and R⁴, taken
 together, represent an oxo group, or the group -(CH₂)_q-, where q is an integer from
 2 to 5, and where R⁵ represents hydrogen, hydroxy, protected hydroxy, or C₁₋₅
 alkyl and wherein any of the CH-groups at positions 20, 22, or 23 in the side chain
 may be replaced by a nitrogen atom, or where any of the groups -CH(CH₃)-,
 30 -(CH₂)_m-, -(CH₂)_n- or (CR₁R₂)- at positions 20, 22, and 23, respectively, may be
 replaced by an oxygen or sulfur atom.

35. The method of claim 34 wherein the compound is administered orally.

36. The method of claim 34 wherein the compound is administered parenterally.

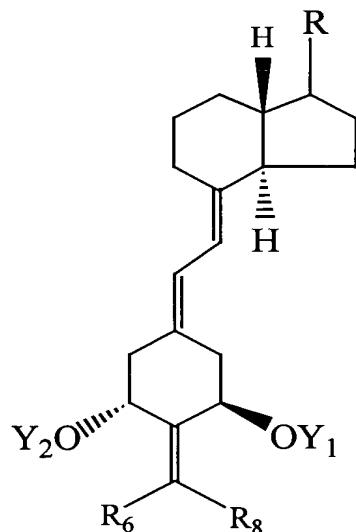
37. The method of claim 34 wherein the compound is administered transdermally.

38. The method of claim 34 wherein the compound is administered topically.

39. The method of claim 34 wherein the compound is (20S)-2-methylene-18,19-dinor-1 α ,25-dihydroxyvitamin D₃.

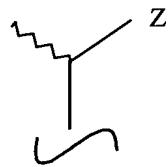
40. The method of claim 34 wherein said effective amount comprises about 0.01 μ g/day to about 100 μ g/day of said compound.

41. A method of treating leukemia, colon cancer, breast cancer, skin cancer or prostate cancer comprising administering to a patient an effective amount of a compound having the formula:



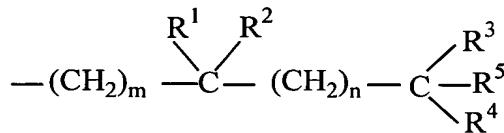
where Y₁ and Y₂, which may be the same or different, are each selected from the
5 group consisting of hydrogen and a hydroxy-protecting group, R₆ and R₈, which
may be the same or different, are each selected from the group consisting of
hydrogen, alkyl, hydroxyalkyl and fluoroalkyl, or, when taken together represent
the group -(CH₂)_x- where x is an integer from 2 to 5, and where the group R is
represented by the structure:

10



where the stereochemical center at carbon 20 may have the R or S configuration, and where Z is selected from Y, -OY, -CH₂OY, -C≡CY and -CH=CHY, where the double bond may have the cis or trans geometry, and where Y is selected from hydrogen, methyl, -COR⁵ and a radical of the structure:

15



where m and n, independently, represent the integers from 0 to 5, where R¹ is selected from hydrogen, deuterium, hydroxy, protected hydroxy, fluoro, trifluoromethyl, and C₁₋₅-alkyl, which may be straight chain or branched and, optionally, bear a hydroxy or protected-hydroxy substituent, and where each of R², R³, and R⁴, independently, is selected from deuterium, deutoalkyl, hydrogen, fluoro, trifluoromethyl and C₁₋₅ alkyl, which may be straight-chain or branched, and optionally, bear a hydroxy or protected-hydroxy substituent, and where R¹ and R², taken together, represent an oxo group, or an alkylidene group, =CR²R³, or the group -(CH₂)_p-, where p is an integer from 2 to 5, and where R³ and R⁴, taken together, represent an oxo group, or the group -(CH₂)_q-, where q is an integer from 2 to 5, and where R⁵ represents hydrogen, hydroxy, protected hydroxy, or C₁₋₅ alkyl and wherein any of the CH-groups at positions 20, 22, or 23 in the side chain may be replaced by a nitrogen atom, or where any of the groups -CH(CH₃)-, -(CH₂)_m-, -(CH₂)_n- or (CR₁R₂)- at positions 20, 22, and 23, respectively, may be replaced by an oxygen or sulfur atom.

42. The method of claim 41 wherein the compound is administered orally.

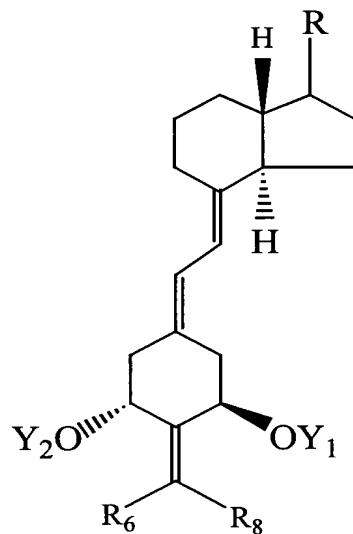
43. The method of claim 41 wherein the compound is administered parenterally.

44. The method of claim 41 wherein the compound is administered transdermally.

45. The method of claim 41 wherein the compound is administered in a dosage of from about 0.01 μ g/day to about 100 μ g/day.

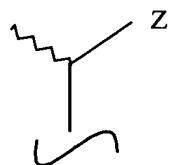
46. The method of claim 41 wherein the compound is (20S)-2-methylene-18,19-dinor-1 α ,25-dihydroxyvitamin D₃.

47. A method of increasing the strength of a bone comprising administering to a patient in need of such treatment an effective amount of a compound having the formula:

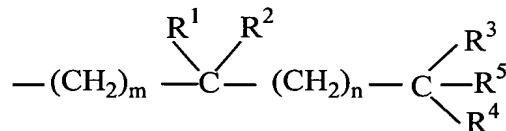


5 where Y₁ and Y₂, which may be the same or different, are each selected from the group consisting of hydrogen and a hydroxy-protecting group, R₆ and R₈, which may be the same or different, are each selected from the group consisting of hydrogen, alkyl, hydroxyalkyl and fluoroalkyl, or, when taken together represent

the group $-(CH_2)_x-$ where X is an integer from 2 to 5, and where the group R is
 10 represented by the structure:



where the stereochemical center at carbon 20 may have the R or S configuration, and where Z is selected from Y, -OY, -CH₂OY, -C≡CY and -CH=CHY, where the double bond may have the cis or trans geometry, and where Y is selected from
 15 hydrogen, methyl, -COR⁵ and a radical of the structure:



where m and n, independently, represent the integers from 0 to 5, where R¹ is selected from hydrogen, deuterium, hydroxy, protected hydroxy, fluoro, trifluoromethyl, and C₁₋₅-alkyl, which may be straight chain or branched and,
 20 optionally, bear a hydroxy or protected-hydroxy substituent, and where each of R², R³, and R⁴, independently, is selected from deuterium, deutoalkyl, hydrogen, fluoro, trifluoromethyl and C₁₋₅ alkyl, which may be straight-chain or branched, and optionally, bear a hydroxy or protected-hydroxy substituent, and where R¹ and R², taken together, represent an oxo group, or an alkylidene group, =CR²R³, or the
 25 group -(CH₂)_p-, where p is an integer from 2 to 5, and where R³ and R⁴, taken together, represent an oxo group, or the group -(CH₂)_q-, where q is an integer from 2 to 5, and where R⁵ represents hydrogen, hydroxy, protected hydroxy, or C₁₋₅ alkyl and wherein any of the CH-groups at positions 20, 22, or 23 in the side chain may be replaced by a nitrogen atom, or where any of the groups -CH(CH₃)-,
 30 -(CH₂)_m-, -(CH₂)_n- or (CR₁R₂)- at positions 20, 22, and 23, respectively, may be replaced by an oxygen or sulfur atom.

48. The method of claim 47 wherein the bone strength is cortical strength.

49. The method of claim 47 wherein the bone strength is trabecular strength.

50. The method of claim 47 wherein the compound is administered orally.

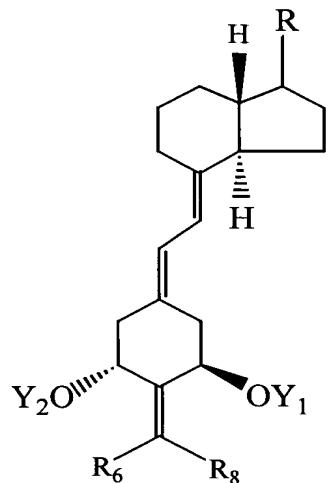
51. The method of claim 47 wherein the compound is administered parenterally.

52. The method of claim 47 wherein the compound is administered transdermally.

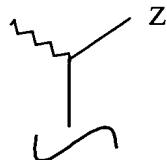
53. The method of claim 47 wherein the compound is administered in a dosage of from 0.01 μ g to 100 μ g per day.

54. The method of claim 47 wherein the compound is (20S)-2-methylene-18,19-dinor-1 α ,25-dihydroxyvitamin D₃.

55. A method of treating an autoimmune disease comprising administering to a patient with said disease an effective amount of a compound having the formula

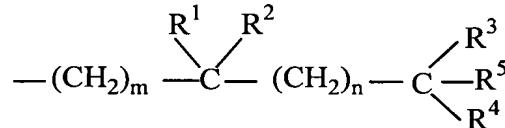


where Y_1 and Y_2 which may be the same or different, are each selected from the
 5 group consisting of hydrogen and a hydroxy-protecting group, R_6 and R_8 , which
 may be the same or different, are each selected from the group consisting of
 hydrogen, alkyl, hydroxyalkyl and fluoroalkyl, or, when taken together represent
 the group $-(CH_2)_x-$ where x is an integer from 2 to 5, and where the group R is
 represented by the structure:



10

where the stereochemical center at carbon 20 may have the R or S configuration,
 and where Z is selected from Y , $-OY$, $-CH_2OY$, $-C\equiv CY$ and $-CH=CHY$, where the
 double bond may have the cis or trans geometry, and where Y is selected from
 hydrogen, methyl, $-COR^5$ and a radical of the structure:

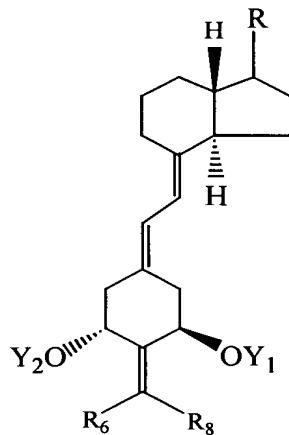


15

where m and n , independently, represent the integers from 0 to 5, where R^1 is
 selected from hydrogen, deuterium, hydroxy, protected hydroxy, fluoro,
 trifluoromethyl, and C_{1-5} -alkyl, which may be straight chain or branched and,
 optionally, bear a hydroxy or protected-hydroxy substituent, and where each of R^2 ,
 20 R^3 , and R^4 , independently, is selected from deuterium, deuteroalkyl, hydrogen,
 fluoro, trifluoromethyl and C_{1-5} alkyl, which may be straight-chain or branched,
 and optionally, bear a hydroxy or protected-hydroxy substituent, and where R^1 and
 R^2 , taken together, represent an oxo group, or an alkylidene group, $=CR^2R^3$, or the
 group $-(CH_2)_p-$, where p is an integer from 2 to 5, and where R^3 and R^4 , taken
 25 together, represent an oxo group, or the group $-(CH_2)_q-$, where q is an integer from
 2 to 5, and where R^5 represents hydrogen, hydroxy, protected hydroxy, or C_{1-5}

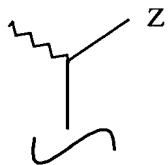
alkyl and wherein any of the CH-groups at positions 20, 22, or 23 in the side chain may be replaced by a nitrogen atom, or where any of the groups -CH(CH₃)-, -(CH₂)_m-, -(CH₂)_n-, or -(CR₁R₂)- at positions 20, 22, and 23, respectively, may be
30 replaced by an oxygen or sulfur atom.

56. The method of claim 55 where the disease is multiple sclerosis.
57. The method of claim 55 where the disease is diabetes mellitus.
58. The method of claim 55 where the disease is lupus.
59. The method of claim 55 wherein the compound is administered orally.
60. The method of claim 55 wherein the compound is administered parenterally.
61. The method of claim 55 wherein the compound is administered transdermally.
62. The method of claim 55 wherein the compound is administered in a dosage of from about 0.01 µg/day to about 100 µg/day.
63. The method of claim 55 wherein the compound is (20S)-2-methylene-18,19-dinor-1 α ,25-dihydroxyvitamin D₃.
64. A method of treating an inflammatory bowel disease comprising administering to a patient with said disease an effective amount of a compound having the formula



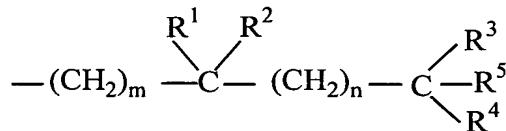
where Y_1 and Y_2 which the same or different, are each selected from the group consisting of hydrogen and a hydroxy-protecting group, R_6 and R_8 , which may be the same or different, are each selected from the group consisting of hydrogen, alkyl, hydroxyalkyl and fluoroalkyl, or, when taken together represent the group

5 $-(CH_2)_x-$ where x is an integer from 2 to 5, and where the group R is represented by the structure:



where the stereochemical center at carbon 20 may have the R or S configuration, and where Z is selected from Y , $-OY$, $-CH_2OY$, $-C\equiv CY$ and $-CH=CHY$, where the

10 double bond may have the cis or trans geometry, and where Y is selected from hydrogen, methyl, $-COR^5$ and a radical of the structure:



where m and n , independently, represent the integers from 0 to 5, where R^1 is selected from hydrogen, deuterium, hydroxy, protected hydroxy, fluoro,

15 trifluoromethyl, and C_{1-5} -alkyl, which may be straight chain or branched and, optionally, bear a hydroxy or protected-hydroxy substituent, and where each of R^2 , R^3 , and R^4 , independently, is selected from deuterium, deuteroalkyl, hydrogen, fluoro, trifluoromethyl and C_{1-5} alkyl, which may be straight-chain or branched, and optionally, bear a hydroxy or protected-hydroxy substituent, and where R^1 and 20 R^2 , taken together, represent an oxo group, or an alkylidene group, $=CR^2R^3$, or the group $-(CH_2)_p-$, where p is an integer from 2 to 5, and where R^3 and R^4 , taken together, represent an oxo group, or the group $-(CH_2)_q-$, where q is an integer from 2 to 5, and where R^5 represents hydrogen, hydroxy, protected hydroxy, or C_{1-5}

alkyl and wherein any of the CH-groups at positions 20, 22, or 23 in the side chain
25 may be replaced by a nitrogen atom, or where any of the groups -CH(CH₃)-,
-(CH₂)_m-, -(CH₂)_n-, or -(CR₁R₂)- at positions 20, 22, and 23, respectively, may be
replaced by an oxygen or sulfur atom.

65. The method of claim 64 wherein the disease is Crohn's disease.
66. The method of claim 64 wherein the disease is ulcerative colitis.
67. The method of claim 64 wherein the compound is administered orally.
68. The method of claim 64 wherein the compound is administered parenterally.
69. The method of claim 64 wherein the compound is administered transdermally.
70. The method of claim 64 wherein the compound is administered in a dosage of from about 0.01 µg/day to about 100 µg/day.
71. The method of claim 64 wherein the compound is (20S)-2-methylene-18,19-dinor-1 α ,25-dihydroxyvitamin D₃.